CMS Performance Note

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27 November 2019 (v2, 03 December 2019)

B-Jet Trigger Performance in Run 2

CMS Collaboration

Abstract

This study shows the performance of the online b-tagging run in 2017 (CSV) and 2018 (DeepCSV).
BJet Trigger:
Performance Plots in Run 2

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Introduction

Bjet trigger performance is measured in di-lepton(eµ) ttbar.
- Sample is dominated by ttbar (small contribution from W+top)
- Di-Lepton triggered events provide unbiased source of b-jets

Event selection:
- 1 isolated electron with pt > 30 GeV
- 1 isolated muon with pt > 20 GeV
- >= 2 offline jets with pt > 30 GeV
- electron and muon pass online e-mu trigger

b-jet efficiency measured using tag-and-probe:
- tag: offline jets with pt > 30 GeV passing medium offline btagging
- probe: offline jet with pt > 30 GeV

Study two varieties of online jets: “calo-jet” and “PF-jets”
- Results for both CSV [1] and DeepCSV [2] btagging algorithms

This study shows the performance of the online b-tagging (CSV) run in 2017.

The performance of the algorithm used for 2018 data taking (DeepCSV) is also included for comparison.

2017 data and Monte Carlo simulated events with the 2017 detector conditions are used. These samples were used to commission the DeepCSV settings run in 2018.

The final part of the Run 2017 dataset (from 13.10.17) is excluded, as it is affected by the failure of the DCDC converters in the CMS pixel system is therefore is not representative of the 2018 data taking conditions.

As a result, the DeepCSV results are an accurate representation of the performance of the algorithm as run in 2018 data. This is validated explicitly by comparing the DeepCSV performance in the 2017 sample directly to that seen in 2018 data.
Online vs Offline b-tagging performance (2017)
Performance of the online (red and blue) and offline (black) b-jet identification efficiency demonstrating the probability for a light-flavor jet to be misidentified as b-jet as a function of the efficiency to correctly identify a b-jet. The performance of the CSVv2 (dashed) and DeepCSV (solid) algorithms are shown. The curves are obtained for online and offline jets with pT > 30 GeV and abs(eta) < 2.4 in simulated tt events. The plot is obtained using the 2017 detector conditions. The performance in this figure serves as an illustration since the b-jet identification efficiency depends on the pT and eta distribution of the jets in the topology as well as the amount of b jets from gluon splitting in the sample.
Impact Parameters

Transverse Impact Parameter
Transverse impact parameters for tracks associated to light-flavour (black) and b-quark (red) jets measured on a sample of simulated ttbar events. The solid lines show the distribution for the offline tracks. The points show the corresponding distribution for tracks used in the trigger. The impact parameters are signed such that track displacements in the direction of the jet have positive values, while tracks with displacements opposite of the jet direction are negative. The plot is obtained using the 2017 detector conditions.
Transverse Impact Parameter Significance

Transverse impact parameter significance for tracks associated to light-flavour (black) and b-quark (red) jets measured on a sample of simulated ttbar events. The solid lines show the distribution for the offline tracks. The points show the corresponding distribution for tracks used in the trigger. The impact parameter significance is defined as the impact parameter divided by the associated uncertainty. The impact parameters are signed such that track displacements in the direction of the jet have positive values, while tracks with displacements opposite of the jet direction are negative. The plot is obtained using the 2017 detector conditions.
Online CSV Discriminator (Data vs MC)
The CSVv2 discriminator distribution for online (PF-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using the 2017 detector conditions. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Online CSV Discriminator (Data vs MC)
The CSVv2 discriminator distribution for online (Calo-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using the 2017 detector conditions. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Online DeepCSV Discriminator (Data vs MC)
The DeepCSV discriminator distribution for online (PF-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Online DeepCSV Discriminator (Data vs MC)
The DeepCSV discriminator distribution for online (Calo-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
CSV Turn-On (Data/MC)
Efficiency to pass the online CSV working points as a function of the corresponding offline CSV value. Data is shown in closed circles. The result of the simulation is shown in open circles. The turn-on with respect to the online Calo jets is shown in blue. The turn-on with respect to the online PF jets is shown in red. The plot is obtained using the 2017 detector conditions. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
CSV Turn-On (Data/MC)
Efficiency to pass the online CSV working points as a function of the corresponding offline DeepCSV value. Data is shown in closed circles. The result of the simulation is shown in open circles. The turn-on with respect to the online Calo jets is shown in blue. The turn-on with respect to the online PF jets is shown in red. The plot is obtained using the 2017 detector conditions. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
DeepCSV Turn-On (Data/MC)
Efficiency to pass the online DeepCSV working points as a function of the corresponding offline DeepCSV value. Data is shown in closed circles. The result of the simulation is shown in open circles. The turn-on with respect to the online Calo jets is shown in blue. The turn-on with respect to the online PF jets is shown in red. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Offline Efficiency vs Online Cut Value (Data/MC)

Efficiency of jets b-tagged offline to pass the online CSV b-tagging requirement as a function of the online cut value. Three offline selections are shown: Loose (Red), Medium (Orange), and Tight (Blue). Data is shown in closed circles; the result of the simulation is shown in open circles. The plot is obtained using the 2017 detector conditions.
Offline Efficiency vs Online Cut Value (Data/MC)

Efficiency of jets b-tagged offline to pass the online DeepCSV b-tagging requirement as a function of the online cut value. Three offline selections are shown: Loose (Red), Medium (Orange), and Tight (Blue). Data is shown in closed circles; the result of the simulation is shown in open circles. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018.
Online CSV Turn-On (Data/MC)

Efficiency to pass the online CSVv2 b-tagging (discriminator > 0.7, light-flavor efficiency ~6%) with respect to jets passing the medium offline DeepCSV operating point as a function of offline jet transverse momentum. The b-jet trigger efficiency is measured using a high b-jet purity di-lepton $t\bar{t}$ selection in the 2017 data-set. Data is shown in black closed circles; the result of the simulation are shown in red open circles.
Online CSV Turn-On (Data/MC)
Efficiency to pass the online CSVv2 b-tagging (discriminator > 0.7, light-flavor efficiency ~6%) with respect to jets passing the medium offline DeepCSV operating point as a function of offline jet pseudo-rapidity. The b-jet trigger efficiency is measured using a high b-jet purity di-lepton $t\bar{t}$ selection in the 2017 data-set. Data is shown in black closed circles; the result of the simulation are shown in red open circles.
Online DeepCSV Turn-On (Data/MC)

Efficiency to pass the online DeepCSV b-tagging (discriminator > 0.24, light-flavor efficiency ~6%) with respect to jets passing the medium offline DeepCSV operating point as a function of offline jet transverse momentum. The b-jet trigger efficiency is measured using a high b-jet purity dilepton $t\bar{t}$ selection in the 2017 data-set. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018. Data is shown in black closed circles; the result of the simulation are shown in red open circles.
Online DeepCSV Turn-On (Data/MC)
Efficiency to pass the online DeepCSV b-tagging (discriminator > 0.24, light-flavor efficiency ~6%) with respect to jets passing the medium offline DeepCSV operating point as a function of offline jet pseudo-rapidity. The b-jet trigger efficiency is measured using a high b-jet purity di-lepton $t\bar{t}$ selection in the 2017 data-set. The plot is obtained using 2017 data & MC but using the DeepCSV algorithm as it was run in 2018. Data is shown in black closed circles; the result of the simulation are shown in red open circles.
DeepCSV Turn-On (2017 vs 2018)
Efficiency to pass the online DeepCSV working points as a function of the corresponding offline DeepCSV value. Data collected in 2018 is shown in closed circles; data collected in 2017 is shown in open circles. The turn-on with respect to the online Calo jets is shown in blue. The turn-on with respect to the online PF jets is shown in red. The plot is obtained using 2017 and 2018 data using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Online DeepCSV Discriminator (Data vs MC)
The DeepCSV discriminator distribution for online (PF-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using 2018 data & 2017 MC using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.
Online DeepCSV Discriminator (Data vs MC)
The DeepCSV discriminator distribution for online (Calo-Jets). Different colors show the contributions in simulations from different jet flavors. The plot is obtained using 2018 data & 2017 MC but using the DeepCSV algorithm as it was run in 2018. A negative value indicates that the tracking preselection has failed and the discriminator is not evaluated.